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Satellite Based ADS-B

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April 2014

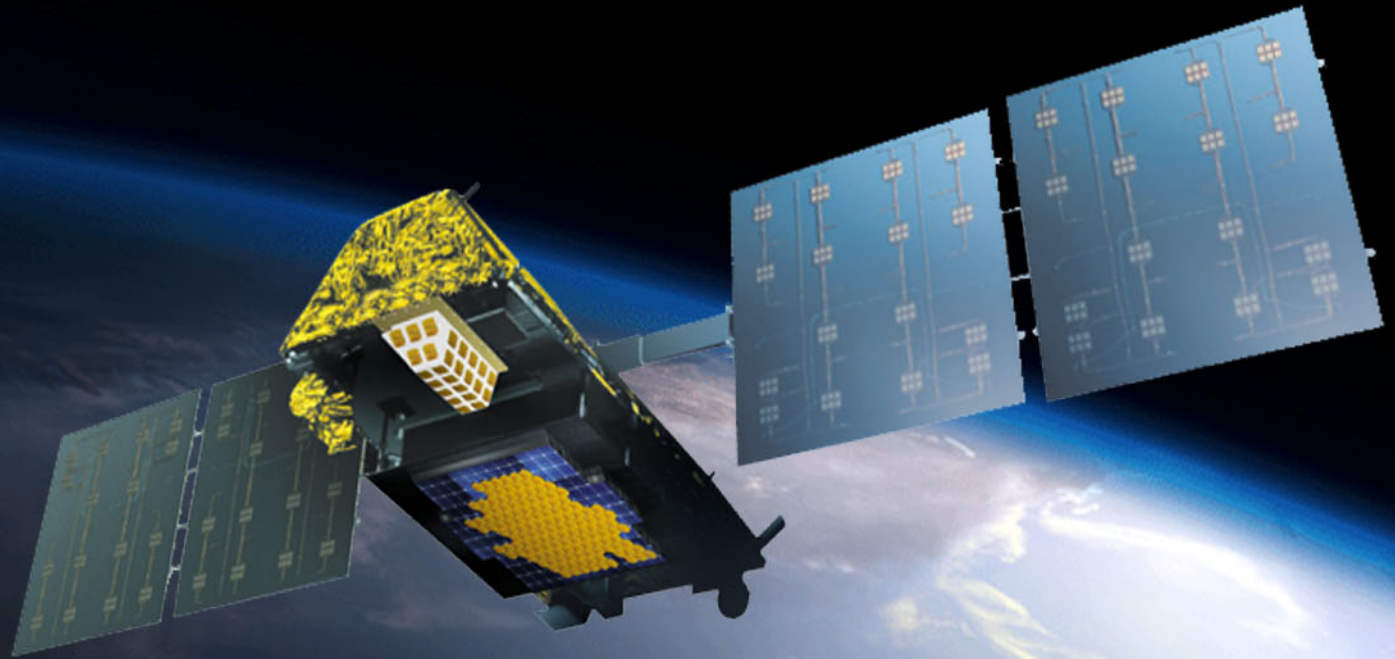
Outline

- Aireon Global ADS-B via LEO satellites
- Why the initial focus on the North Atlantic?
- Benefits Assessment
- Work Underway and Moving Forward
- Frequency Spectrum



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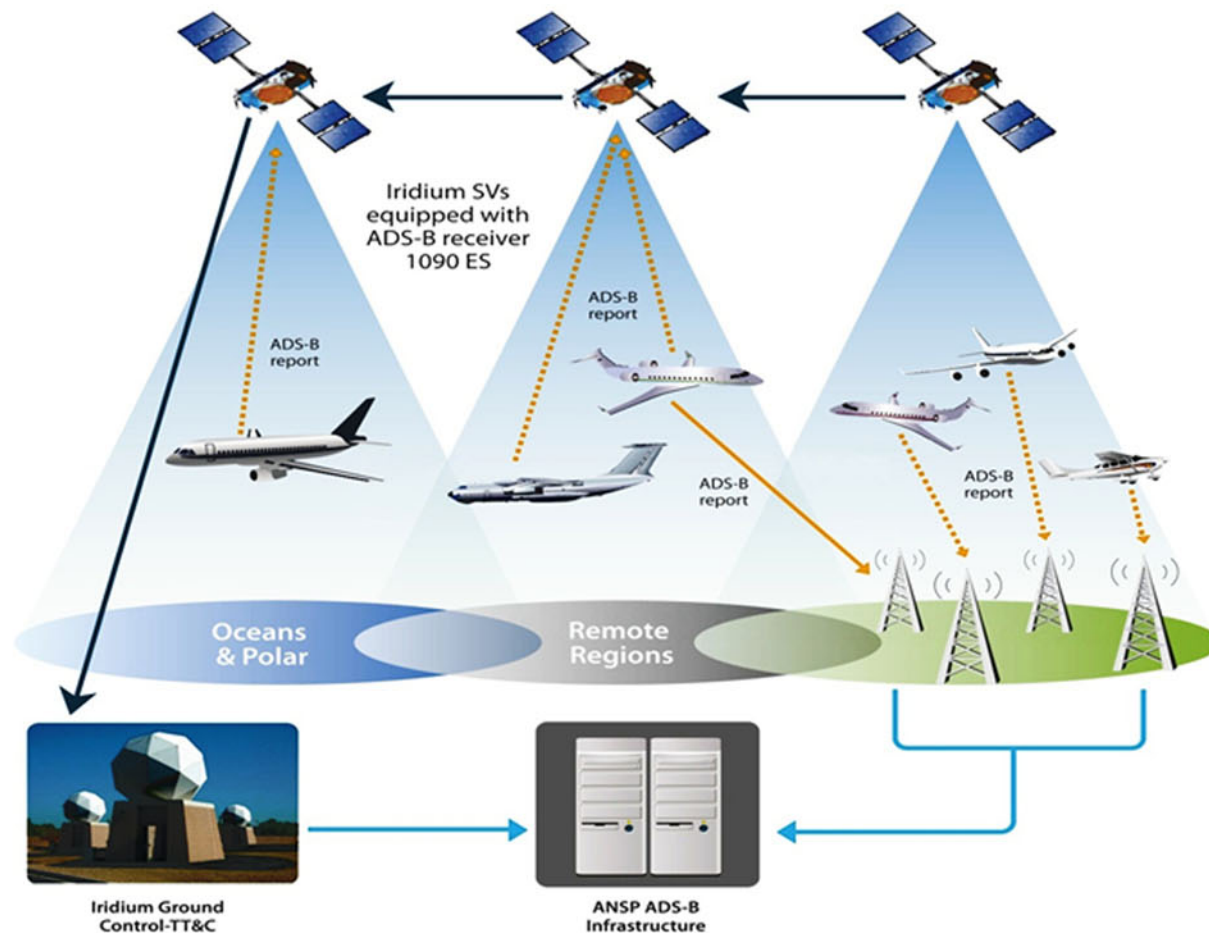
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Goal

To reduce aircraft separation minima through ADS-B (out) via global Low Earth Orbiting (LEO) satellites

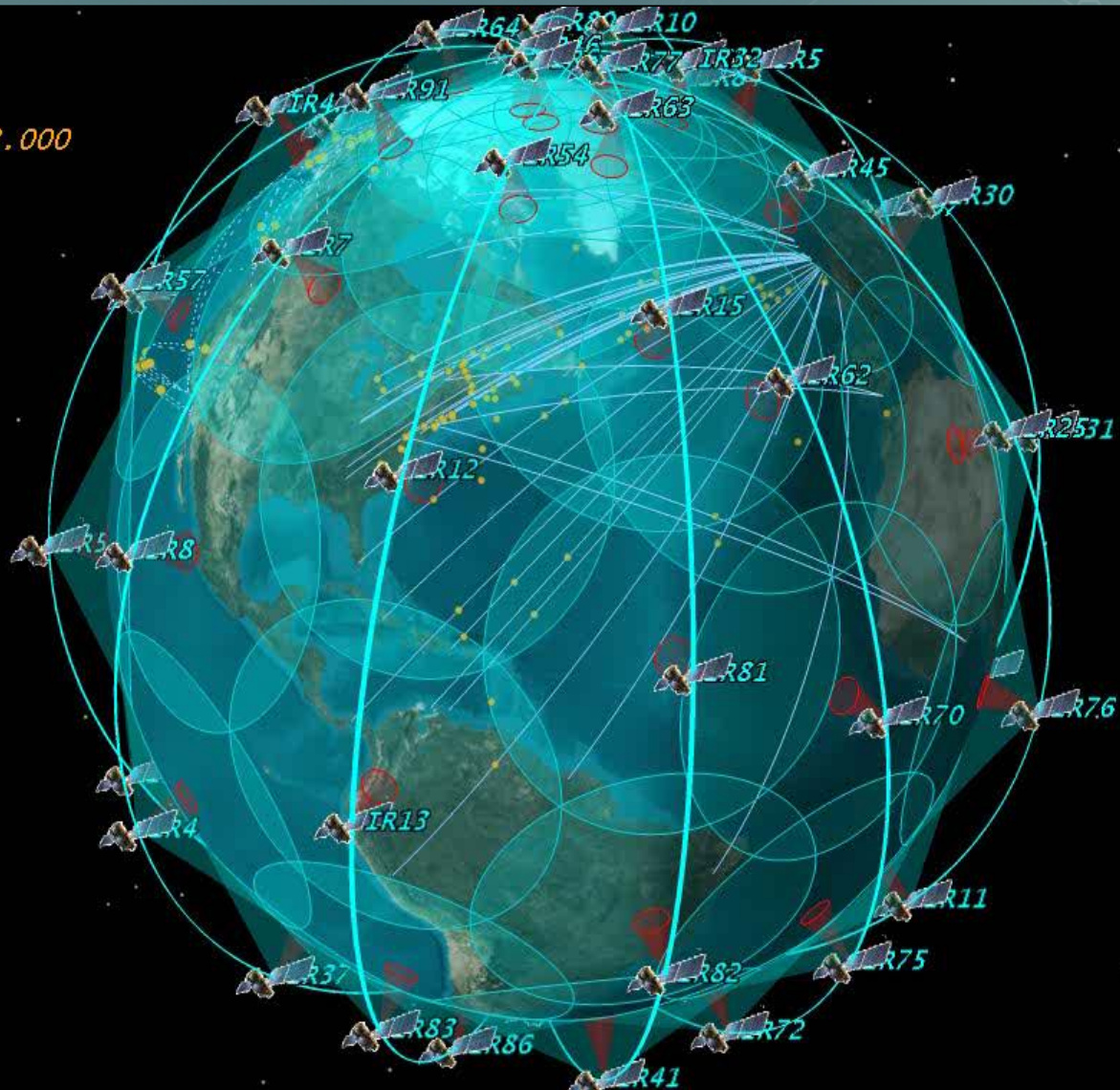
Aireon ADS-B via Low Earth Orbiting (LEO) Satellites



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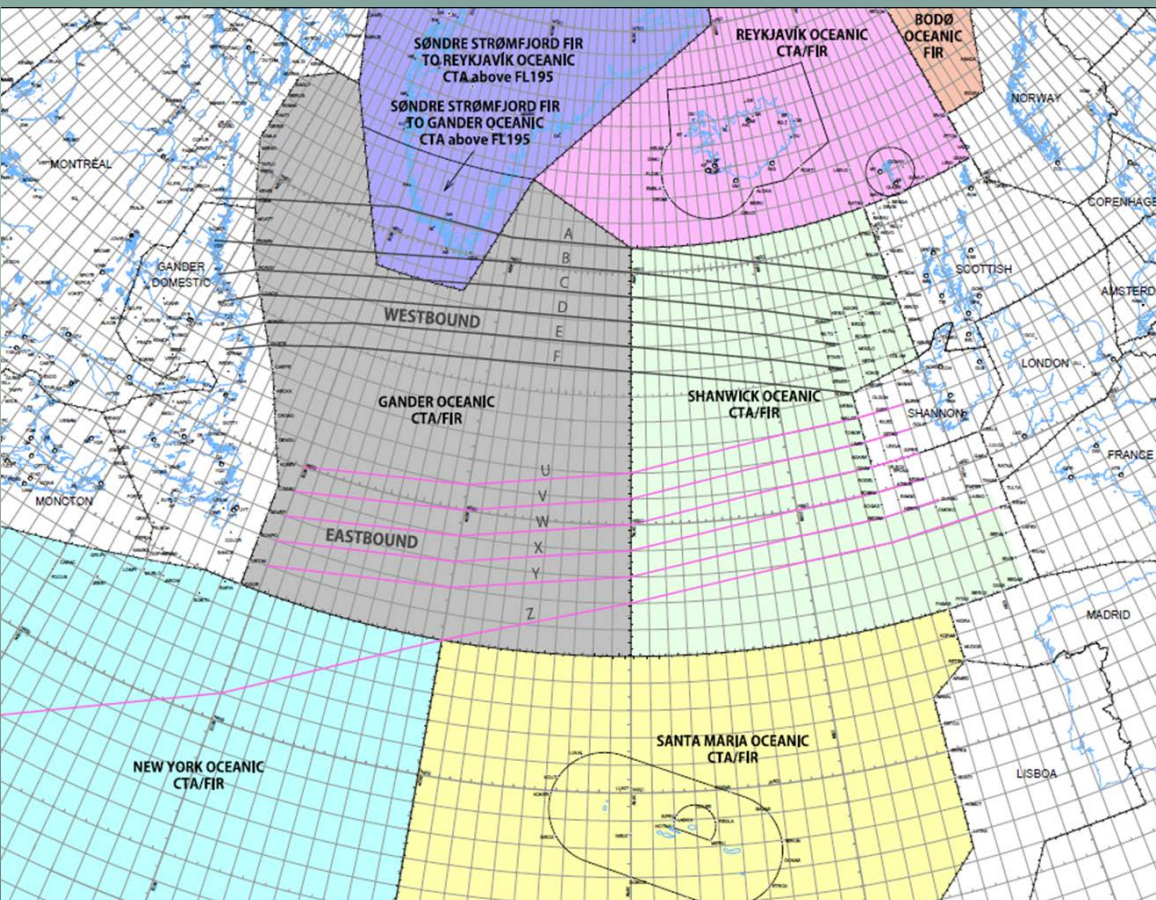
Earth Inertial Axes

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Focus on North Atlantic Oceanic Airspace



- Organized Track Structure NAT OTS
- Eastbound Tracks take advantage of tail winds
- Westbound Tracks avoid head winds
- Procedural Airspace = large distances
- Changes to flight levels, routes, speed by exception

Gander/Shanwick Airspace Today

- **1,000** flights per day
(1,300 peak summer day)
- **350,000** commercial flights
per year
- **+23,000** military & GA
flights per year
- **90%** of the flights are already
ADS-B equipped
- **78%** of flights are Data Link
(FANS 1/A) equipped
- **80%** are capable and use Controller
Pilot Data Link Communications
(CPDLC)



The background of the slide is a composite image of a large commercial airplane in flight, viewed from below. The image is composed of several hexagonal segments, each showing a different part of the aircraft: the cockpit, the wings, the engines, and the landing gear. The sky is a clear blue. A dark blue banner is positioned across the middle of the image, containing the text "Benefits Assessment" in white.

Benefits Assessment

Aireon ADS-B System Benefits

Safety

- ADS-B provides near real time aircraft surveillance
- Improves situational awareness, conflict detection and reaction/resolution
- Aircraft would have more flexibility in emergency situations
- Provides surveillance source separate from the communications (CPDLC) network sources
- More complete and accurate reporting of aviation occurrences, allowing better management of safety risk and better support of the Safety Management System

Aireon ADS-B System Benefits

Environmental/Efficiency

- More efficient “domestic-like” flight trajectories in oceanic airspace
- More predictable airline cost planning
- Climb/Descend and vary speed to chase wind push and avoid headwinds
- Improve opposite direction and crossing traffic profiles
- Significant worldwide reductions in greenhouse gas (GHG) emissions

Aireon ADS-B System Benefits

Predictability/Reliability

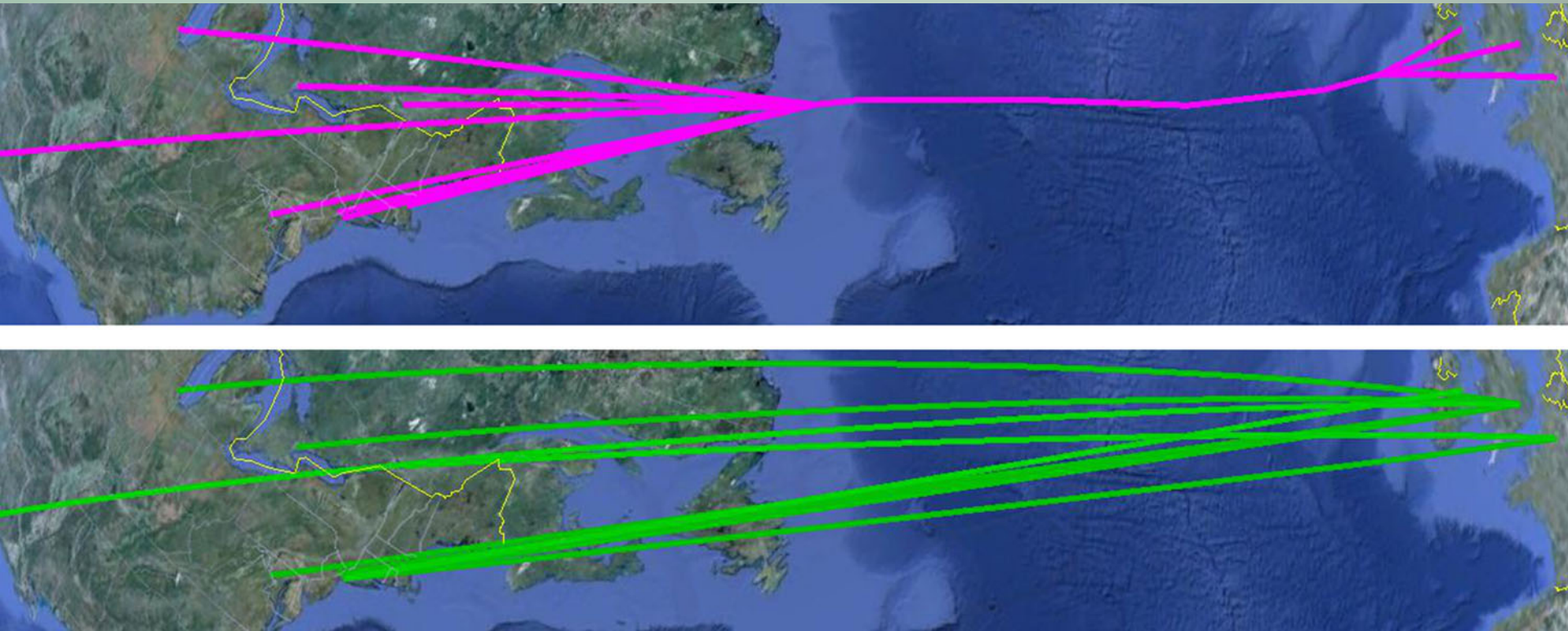
- Access to ADS-B data could support traffic flow management-sequencing, merging and balancing for major cities in eastern North America and Western Europe
- Supports information sharing and collaborative process
- SWIM requires flight planning systems, dispatch, and airline gate-to-gate management to become more sophisticated and efficient. Surveillance via LEO satellite ADS-B will accommodate this.

Aireon ADS-B System Benefits

Supporting ASBU implementation

- B1-SWIM: Performance Improvement through the application of System-Wide Information Management (SWIM)
- B0-FRTO: Improved Operations through Enhanced En-Route Trajectories
- B1-FRTO: Improved Operations through Optimized ATS Routing
- B0-NOPS: Improved Flow Performance through Planning based on a Network-Wide view
- B1-NOPS: Enhanced Flow Performance through Network Operational Planning
- B0-ASUR: Initial Capability for Ground Surveillance
- B0-SNET: Increased Effectiveness of Ground-based Safety Nets
- B1-TBO: Improved Traffic Synchronization and Initial Trajectory-Based Operation
- B1-RPAS: Initial Integration of Remotely Piloted Aircraft (RPA) Systems into non-segregated airspace

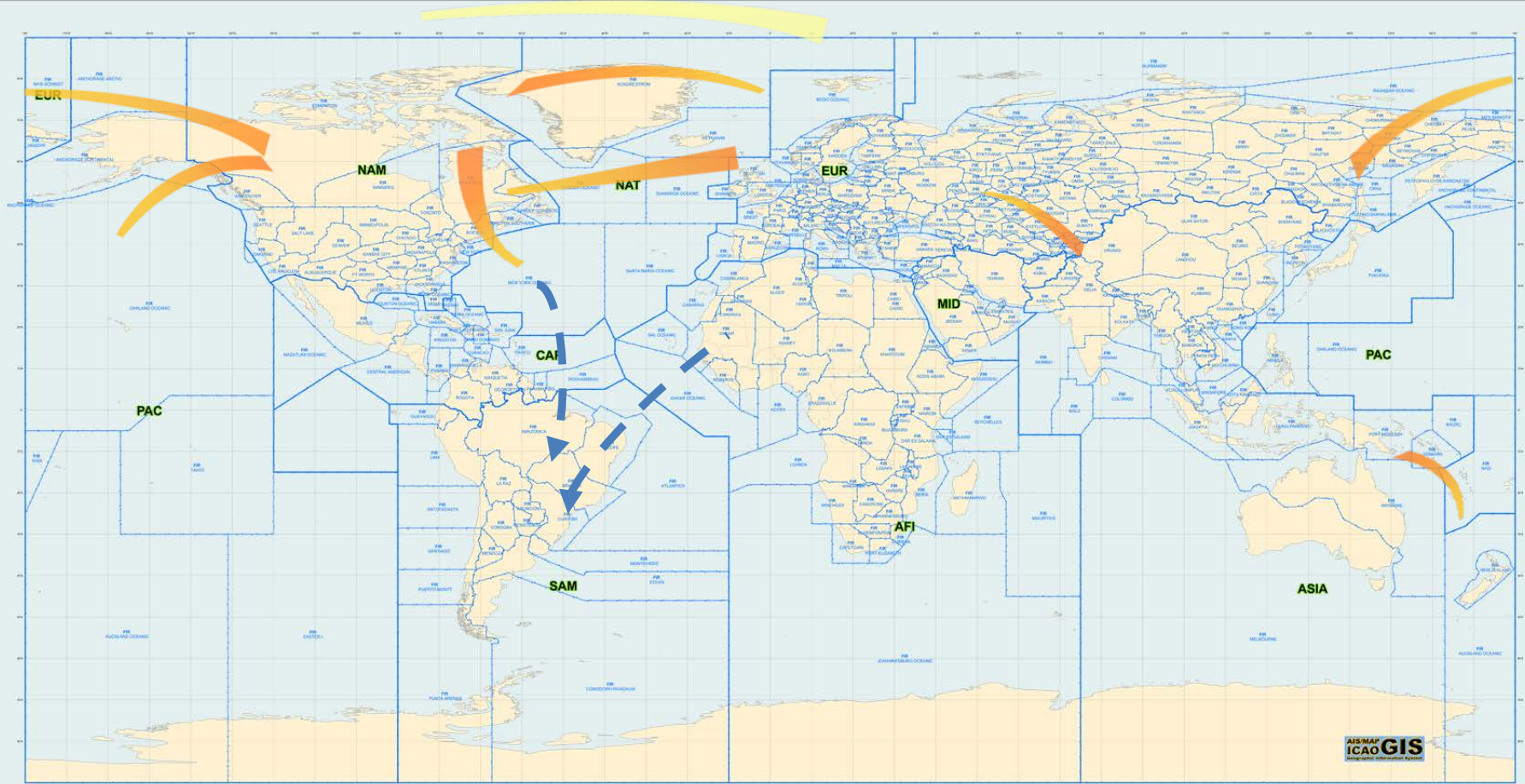
Overview of Traffic on Tracks and No Tracks



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Global Oceanic ADS-B Benefits



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Initial Oceanic Assessment

- High level assessment of 8 oceanic areas
- Based on 1,000' climb fuel savings
- Up to 3 climbs per flight
- Vetted with IATA airline member familiar with oceanic operations
- Considered conservative and achievable

Oceanic Assessment Benefits

Estimated \$439 million in 2018

Major Oceanic FIRs	Commercial IFR Flights (000s)	Total Fuel Climb Savings (000s)	GHGs (000s Tonnes CO ₂ Equivalent)
Pacific	131	\$169,776	446.4
Shanwick / Gander	390	\$127,000	332.8
New York-Santa Maria	138	\$64,584	169.8
US Coastal	109	\$7,358	19.3
Tasman Sea	48	\$3,240	8.5
Mumbai	22	\$1,337	3.5
North Atlantic above 65°	46	\$21,528	56.6
South Pacific	20	\$43,920	115.5
	904	\$438,742	1,152.4

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Work Underway and Moving Forward



Payload being developed by Harris Corporation



- Harris selected to build 81 space-qualified ADS-B receivers in June 2012
- 50+ years designing and manufacturing space hardware and major FAA contractor
- Design phase complete; production starting

Hosted Payload Operations Center to be supported by Iridium

- Developed by an Iridium/Boeing team in Virginia and Arizona



Systems engineering and ground data processing system by Exelis

- Exelis has significant expertise and existing infrastructure supporting the FAA ADS-B terrestrial system deployment
- Successful Preliminary Design Review completed in Sep 2013

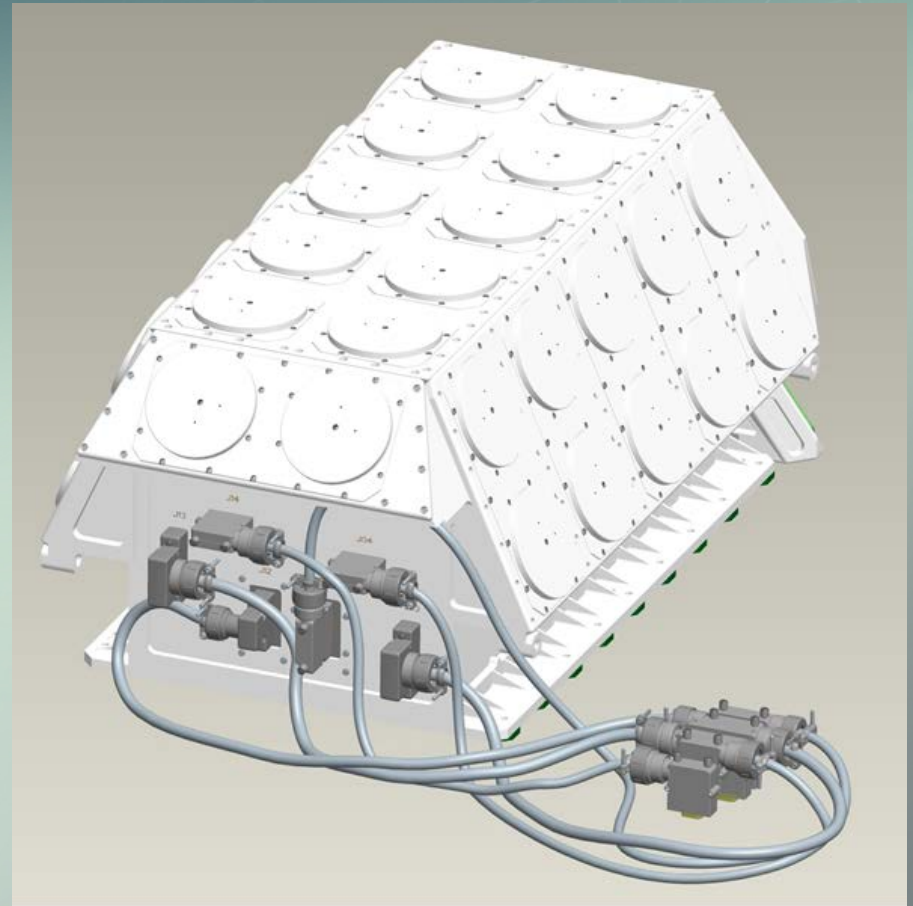
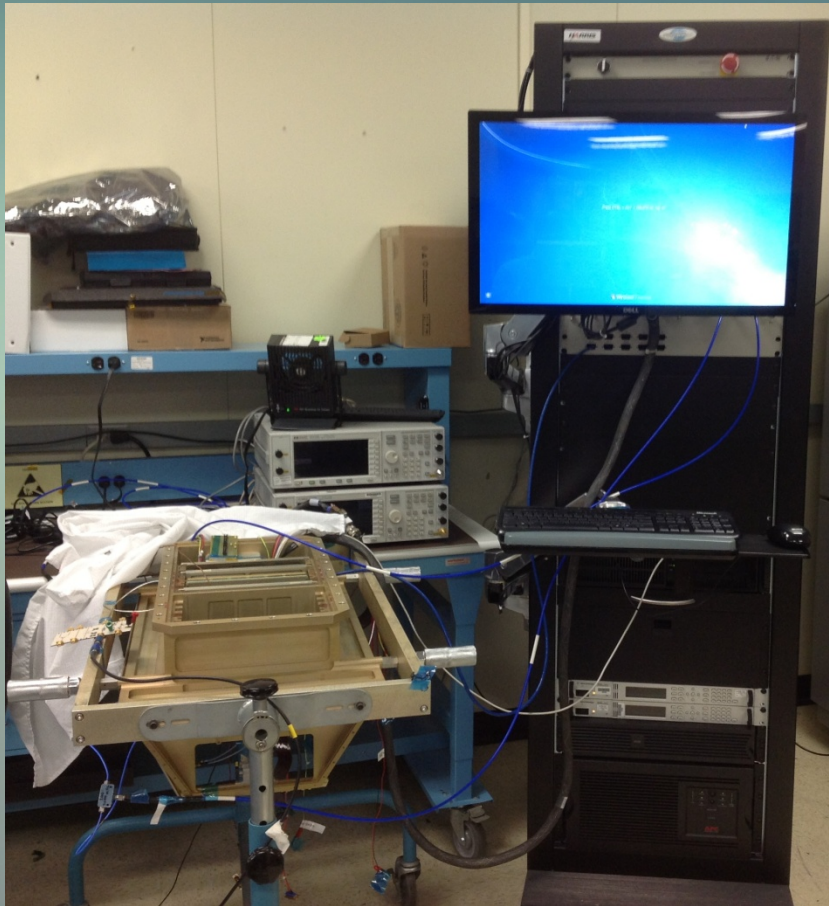
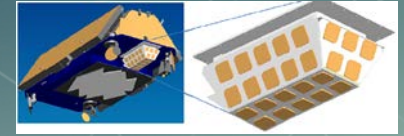


On-track to meet first launch in early 2015
Initial Operations Capability late 2017

Harris ADS-B Payload Development On Target

- Harris ADS-B Payload Critical Design Review successfully completed in May 2013
- Payload completed the Test Readiness and Production Readiness reviews in October 2013
- Payload Qualification Unit completed space qualification testing in March 2014
- Payload Qualification Unit will be shipped to Thales Alenia Space in France for further integration and testing with the satellite
- Production of Payload Units has begun

Hosted Payload

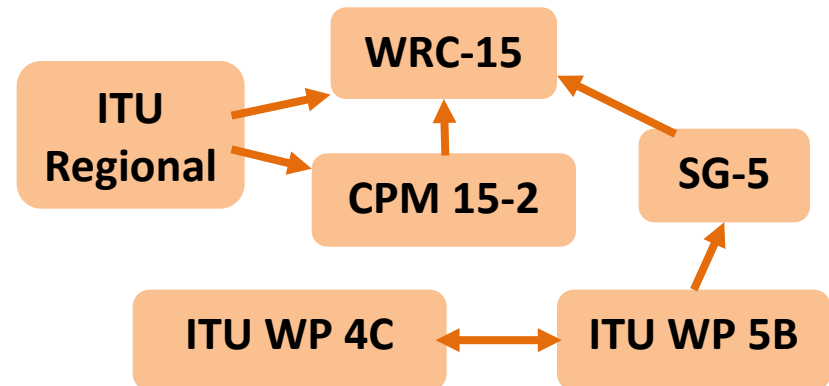
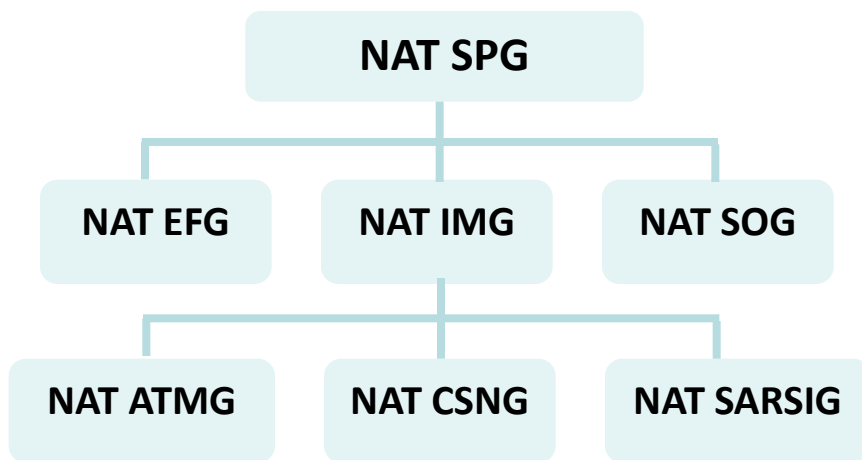


Inverted Hosted Payload

Coverage

- Avionics standards identify classes of airborne transmitters with power outputs of 125 Watts, 250 Watts and 500 Watts
- Gaps in predicted coverage are associated with:
 - Cone of Silence – caused by aircraft antenna
 - Imperfect overlap of adjacent satellite coverage patterns
 - FRUIT – Interference from other ground-based and airborne transmitters





ICAO Regional Groups

NAM/CAR ANI/WG/1
EANPG 55
NACC WG/4
SAM IG/13
MID ASBU Workshop
APAC ATM SG
APANPIRG
TRASAS/4

CPWG

Transport Canada
Industry Canada

Other/Related
NAT Surveillance
Corridor
ADS-B 4G

ICAO

Assembly

BUDSS

ACP WG-F

ATMOPSP

12th Air
Navigation
Conference

SASP

OPLINKP

Regulatory Roadmap

Focus on 4 Areas:

1. ICAO North Atlantic (NAT)
2. ICAO Global Assemblies and Panels
3. International Telecommunication Union (ITU)
4. Other Stakeholders – Transport Canada, CPWG (Cross Polar Working Group), ADS-B 4G, etc.

1. ICAO North Atlantic (NAT)

- NAT SPG contributory groups (NAT IMG, NAT SOG & NAT EFG) have received initial CONOPS briefings
- NAT Economic and Financial Group (EFG) also received Benefits Analysis
- NAT EFG is further exploring overall NAT benefits
- Next contributory group meetings in May and June
 - Will focus on support and work to be done.
 - Will present high level safety plan (to NAT Safety Oversight Group – NAT SOG)

2. ICAO Global Assemblies & Panels

- Presentations made to ICAO regional groups on the initiative
- Separation and Airspace Safety Panel (SASP) provided input on how to approach collision risk modelling
- CONOPS will be presented to new ICAO Air Traffic Management Operations Panel (ATMOPSP) in April
- ICAO Position for the International Telecommunication Union (ITU) World Radiocommunication Conference 2015 (WRC-15) currently **DOES NOT** include protection for 1090 MHz for aircraft to satellite
- Updated ICAO Position may include information about space-based ADS-B frequency allocation requirements

3. International Telecommunication Union (ITU)

Goal is that the ITU will approve allocation of 1090MHz for Aircraft to Satellite ADS-B signal at the World Radio Conference (WRC) in November 2015

Industry Canada submitted a proposal that CITEL (a Regional ITU Group) recommend this subject be included in ITU Regional Director's Report so it can be added to WRC-15 agenda

Supporting Proposed Draft New Report (PDNR) has been developed by ITU Working Parties and may be included in updated ICAO Position

Briefing planned at Asia-Pacific Telecommunity (APT) Preparatory meeting for WRC-15

Working with as many ITU Regions as possible on the frequency allocation/WRC-15 agenda issue

4. Other Stakeholders

Transport Canada

- Regular coordination meetings on ICAO working papers
- Good cooperation on numerous initiatives, particularly frequency spectrum issue

Cross Polar Working Group

- Presentation made on the Space Based ADS-B initiative with positive feedback from participants

ADS-B 4G meeting in Ottawa February 2014

- Presentation on concept positively received

Actions Going Forward

- Continue to collaborate with ANSPs, IATA/industry and ICAO/regulator to demonstrate and validate incremental improvements.
- Leverage existing technology and continue to improve service, e.g., RLongSM and RLatSM.
- Operational trials involving airlines/ANSPs will be used to demonstrate capabilities and support the safety case



In summary

- Global ADS-B Surveillance is a “Game Changer” for aviation
- Significant fuel & GHG savings
- Avoids ADS-B ground based replacement or some initial installation costs
- Benefits to domestic traffic can be realized in remote areas or through improved air traffic flow management to and from oceanic airspace
- Public will benefit from safer + more expeditious flights in remote, polar and oceanic airspace worldwide
- Opportunity to boost aviation innovation & the environment globally

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Questions?